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(54) Measuring instruments

(57) A gauge calibration system comprises a measuring instrument 1 having a fixed probe 2 and a moveable probe 3, which are adapted to bear against a gauge to be calibrated. The moveable probe 3 is of granite, and is supported on a granite base 4, by means of three-spaced air bearings 15, 16. A pneumatic device is provided for applying a constant force to the moveable probe 3, to maintain the probe 3 in a measuring position. The probes 2 and 3 are provided with slips 23, for contact with the gauge to be measured. A table 31 for supporting a gauge to be measured is itself supported on air bearings 32, and constrained for limited movement within a frame around the table.

A single output line 7 from the measuring instrument 1 leads to a data processing system 8, which is adapted to receive and store data from the measuring instrument, output the stored data, and output a set of instructions to a user of the instrument.

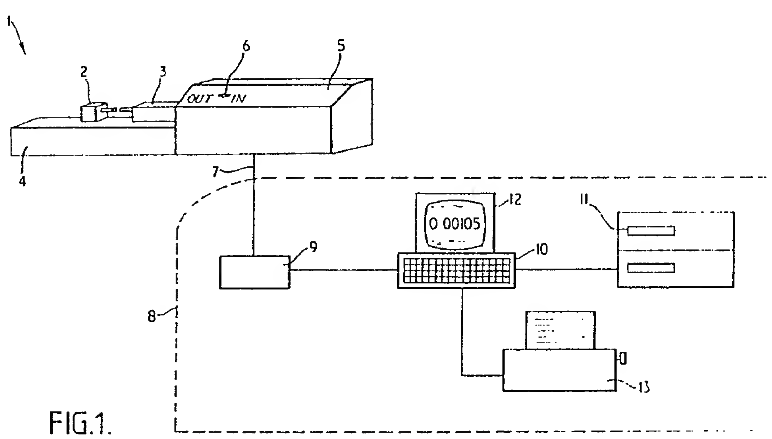

FIG.1.

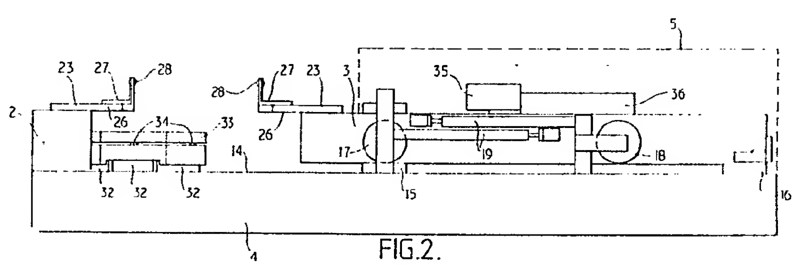

FIG.2.

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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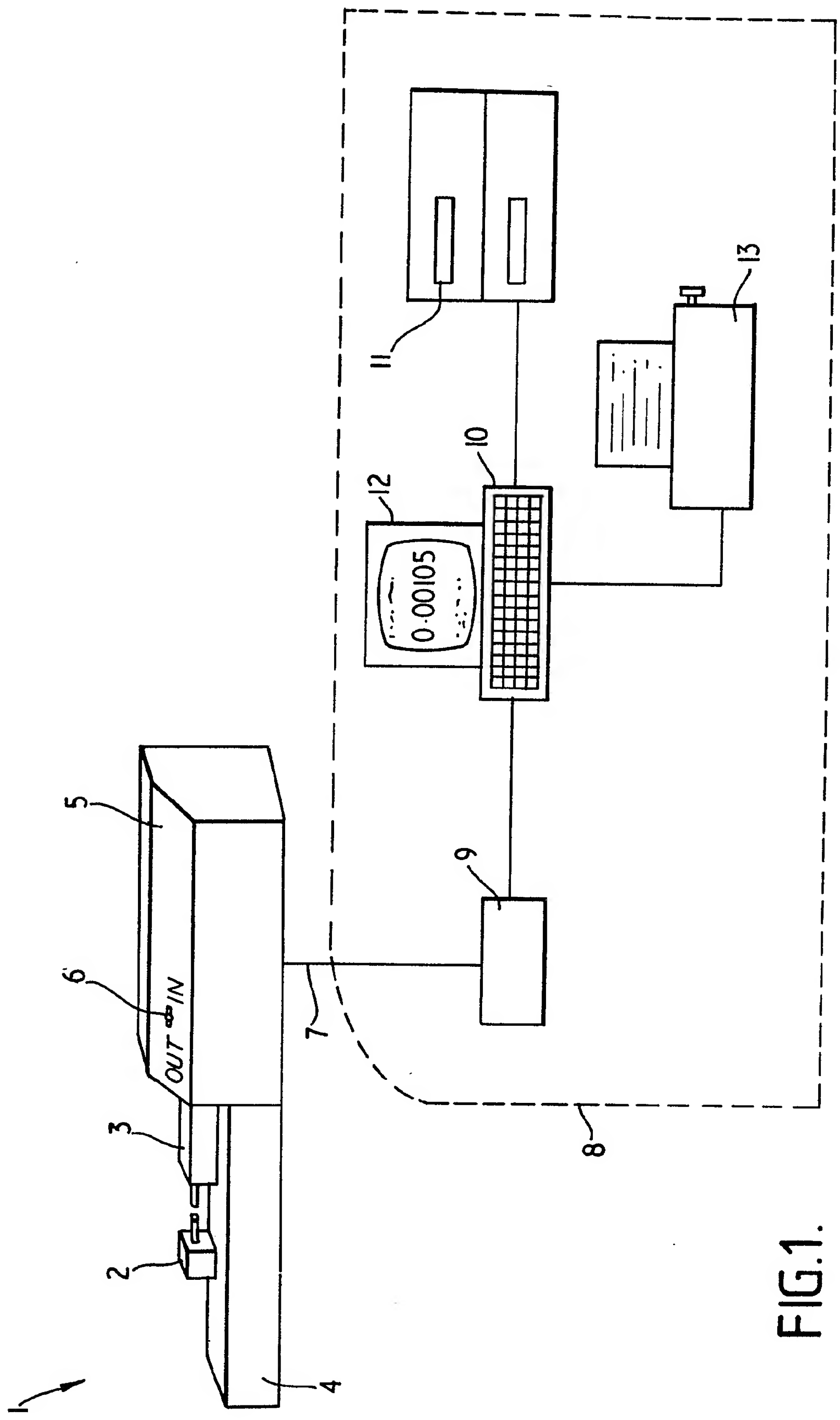

FIG.1.

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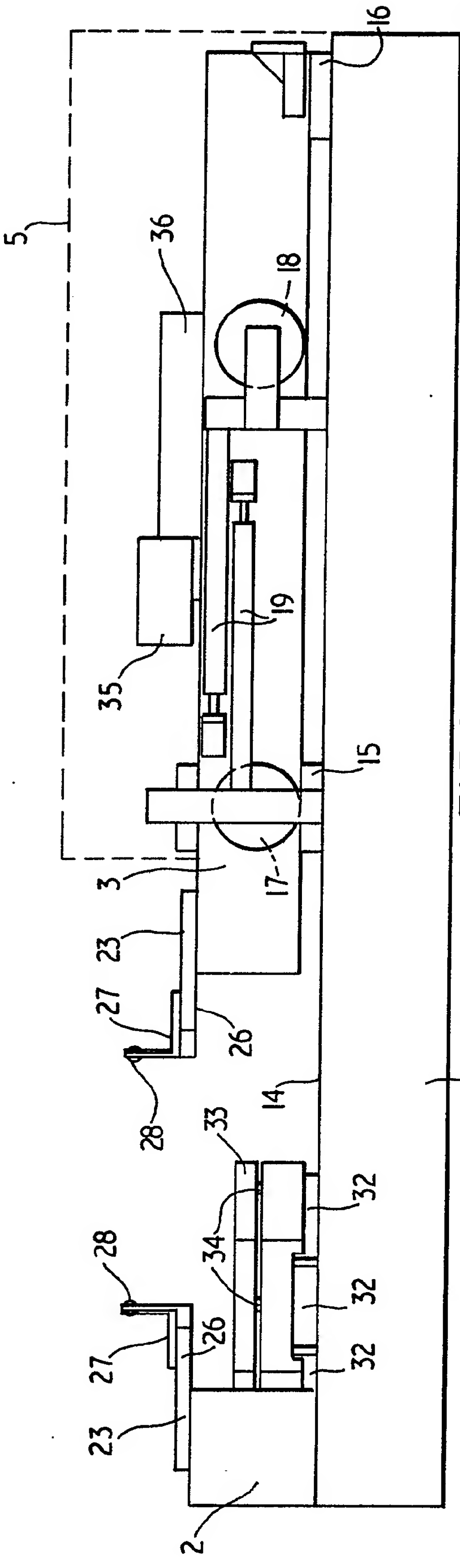

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FIG.2.

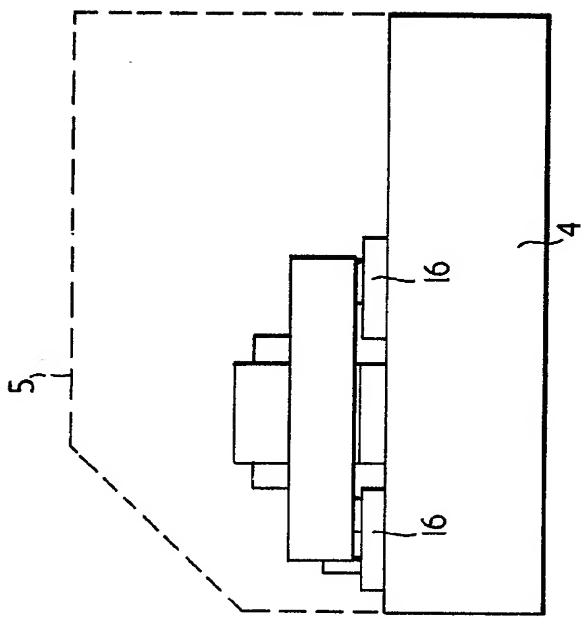

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FIG.3.

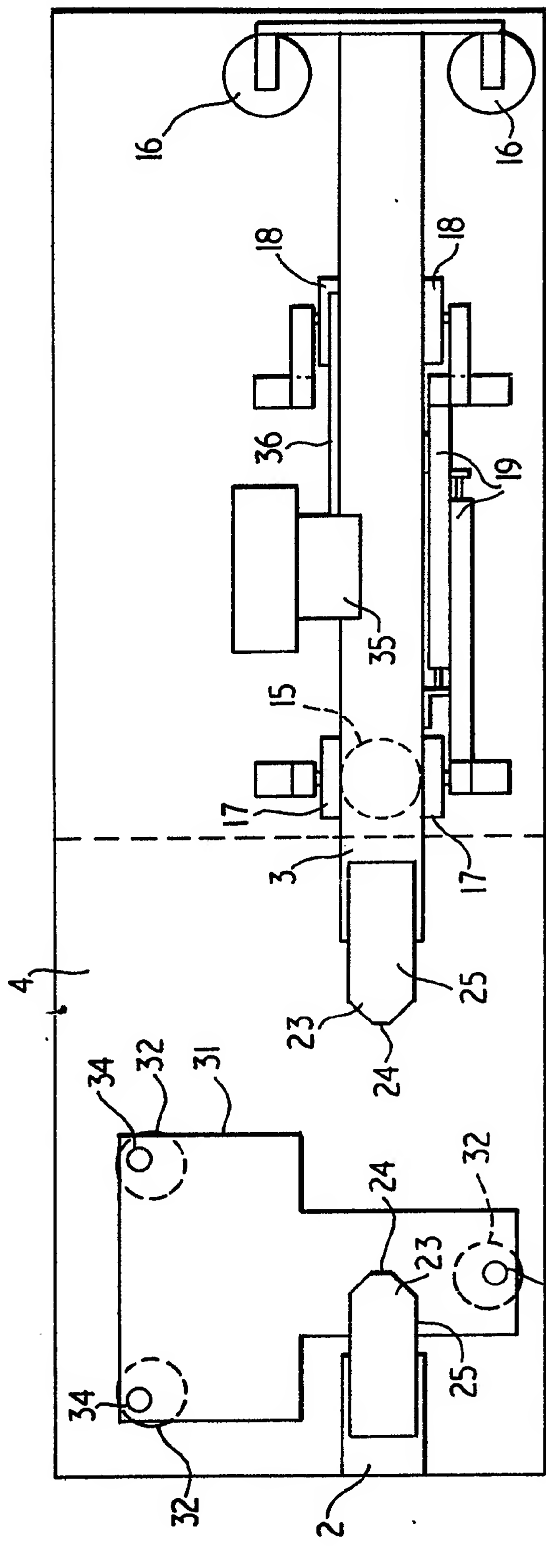

FIG.4.

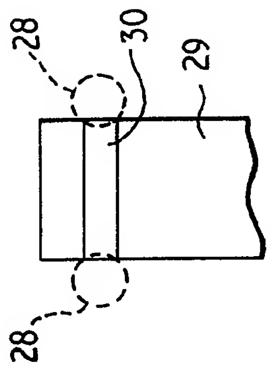

FIG.6.

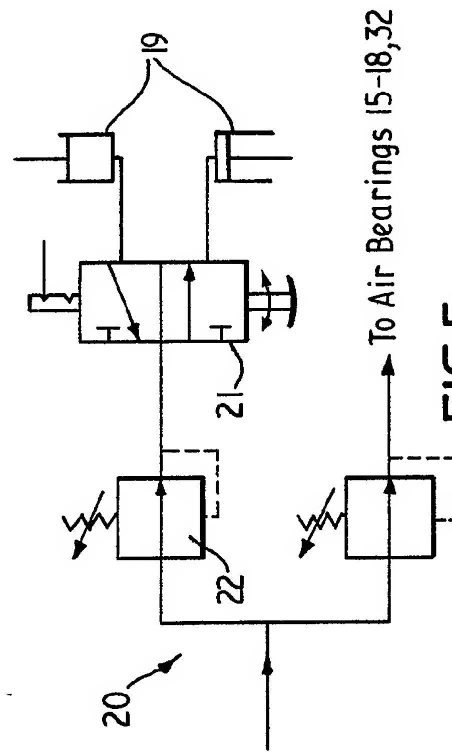

FIG.5.

SPECIFICATION
Measuring instruments

This invention relates to measuring instruments and is particularly although not exclusively concerned with measuring instruments for calibrating dimension gauges (referred to below simply as "gauges").

Most engineering firms keep a large number of gauges for checking the accuracy of dimensions. The accuracy of such checking depends of course upon the accuracy of the gauges themselves, and it is therefore customary both to calibrate the gauges at regular intervals, and to maintain written records of such calibrations. This is especially important in precision engineering, where customers may specify exacting gauge calibration as part of a contract. The development of National Quality Standards has also accentuated the need for engineering firms to maintain adequate systems for gauge calibration and control.

One typical way of calibrating a gauge is to compare the gauge with a slip gauge. A slip gauge is a very accurately finished block with highly parallel faces (e.g. finished to 10^{-6} inch accuracy). The thickness of slip gauges may vary from, for example, one-tenth of a thousandth of an inch to four inches. Slip gauges are thus assembled to make up any desired standard, for comparison with a gauge to be calibrated. Such a method of gauge calibration is rather labour intensive.

Automatic gauge calibration machines are available, which utilize fixed and moveable probes, and give direct readings on a scale. However, such machines tend to be very sophisticated (and therefore expensive) in order to cater for virtually all types of gauges. As a very large proportion of gauges are of a relatively simple type (e.g. fixed type or simple variable, as vernier calipers and micrometers), many firms or workshops cannot justify the expense of such sophisticated machines.

Certain preferred embodiments of the invention aim to provide measuring instruments which may be used to calibrate gauges in a relatively simple and reliable manner.

Another aspect of conventional gauge calibration techniques which is rather labour intensive is the maintenance of written calibration records, usually on a series of gauge record cards. Analysis of records and planning of calibration programmes is also a tedious task. Such a system also carries the danger of clerical errors in entering data, and the misplacing of cards.

Certain preferred embodiments of the invention aim to provide systems which may be improved in these respects.

According to a first aspect of the present invention, there is provided a measuring instrument comprising a base and a probe which is moveable on the base, towards and away from a measuring position, the probe being supported on the base by means of three spaced air bearings.

Preferably, one of the air bearings is mounted at or adjacent a front end of the probe, and the other two air bearings are mounted at or adjacent a rear end of the probe.

The measuring instrument preferably further comprises at least one pair of oppositely facing further air bearings, adapted to guide respective side faces of the probe. Two pairs of said further air bearings may be provided, spaced along the length of the probe.

According to a second aspect of the present invention, there is provided a measuring instrument comprising a probe which is moveable towards and away from a measuring position, and means for applying a constant force to the probe to maintain the probe in a measuring position.

Preferably, said means is adjustable to adjust said constant force. Said means may comprise an electromagnetic device, an hydraulic device, or a pneumatic device.

Such a pneumatic device may comprise a graphite piston in a glass air cylinder, and may be adaptable to apply force selectively in one of two opposite directions. A pair of glass air cylinders may be provided, each having a respective graphite piston therein, and each being adapted to operate in a respective one of said two opposite directions. The pneumatic device may include at least one pressure regulator valve for the adjustment of said constant force.

According to a third aspect of the present invention, there is provided a measuring instrument comprising a probe which is moveable towards and away from a measuring position, and a slip mounted on the probe, for contact with an object to be measured.

Preferably, the slip is removeably mounted on the probe. There may be provided a plurality of interchangeable slips for mounting on the probe.

Preferably, the or each slip comprises a first smooth under face adapted to be mounted on a similarly flat smooth upper face of the probe, and a flat smooth abutment face precisely at right angles to said under face, for contact with an object to be measured. The or each slip may further comprise a first smooth side face precisely at right angles to its respective said abutment face.

There may be provided at least one slip having a flat smooth under face adapted to be mounted on a similarly flat smooth upper face of the probe, and an upstanding arm carrying a ball for contact with an object to be measured. Such a slip may be used for internal measurements.

According to a fourth aspect of the present invention, there is provided a measuring instrument comprising support means for supporting an object at a measuring position and sensor means for sensing an object at said position, the support means comprising a table supported on air bearings, and constrained for limited movement within a frame around the table.

Preferably, said frame is moveable over a surface of the measuring instrument. The support

table may with advantage be supported on three said air bearings, and may be generally T-shaped.

The support table is preferably provided with a support surface, the plane of which is adjustable. To this end, the support surface may be secured in position by means of three screw-threaded adjustable members.

Advantageously, there may be provided a plurality of interchangeable support members which are adapted to be detachably secured to the support table.

In the measuring instrument according to any one of the first to fourth aspects of the invention, the base of the measuring instrument may be of granite, having a flat, smooth upper face on which the probe is mounted. The probe itself may also be of granite.

The measuring instrument may include an opto-electrical reading head for detecting movement of the probe and providing an electrical signal proportional thereto.

Preferably, the moveable probe co-operates with a fixed probe to measure objects therebetween. The fixed probe may be located selectively at any one of a plurality of predetermined positions.

The measuring instrument may include probe members for measuring internal dimensions, each probe member comprising an upright portion in which a precision ball is mounted. An alignment device may be provided for aligning said probe members, the device being formed therethrough with a single hole, of a diameter to accept part of one of said balls at each mouth of the hole.

According to a fifth aspect of the present invention, there is provided a data processing system adapted to receive and store data from a measuring instrument, output such stored data, and output a set of instructions to a user of the instrument.

The data processing system preferably includes an interface adapted to receive electrical signals directly from a measuring instrument, and output data signals for storage in the data processing system. In a novel arrangement, the interface may be adapted to sample an electrical signal from a measuring instrument, and pass the sampled values successively to a store of the system. The interface may be adapted to sample continuously successive bits of a binary coded number. The binary coded number may be generated in the interface. The interface may be adapted to sample said bits only one at a time.

The system may include display means for displaying an output of the system, and/or printer means for printing an output of the system.

The system is preferably adapted to output any selected one of a plurality of sets of instructions to a user of a measuring instrument.

Said sets of instructions may comprise a set of zeroing instructions, for zeroing the respective instrument, and a set of measuring instructions, for carrying out a measurement.

Said sets of instructions may comprise a set of measuring/storing instructions, for carrying out a measurement and storing the date, and/or a set of data input instructions, for storing data without a measurement operation, and/or a set of object listing instructions, for listing objects due to be measured.

The data processing system may with advantage be adapted to extrapolate probable future measurement data from existing actual measurement data.

The system is preferably adapted to receive measurement data from a dimension measuring instrument, and in particular a dimension gauge calibration instrument.

The data processing system may be adapted to output control instructions to a respective measuring instrument.

The invention extends to a data processing system in accordance with the fifth aspect of the invention, in combination with a measuring instrument, and in particular where the measuring instrument is in accordance with any one of the first to fourth aspects of the present invention.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings, in which:

Figure 1 is a schematic drawing of a gauge calibration system;

Figure 2 shows a measuring instrument of the system, in side elevation;

Figure 3 shows the measuring instrument in end elevation;

Figure 4 is a plan view of the measuring instrument;

Figure 5 is a schematic diagram of an air supply circuit for the measuring instrument; and

Figure 6 illustrates a set-up gauge for the measuring instrument.

The gauge calibration system illustrated in Figure 1 comprises a measuring instrument 1 having a fixed probe 2 and a moveable probe 3, which are adapted to bear against a gauge to be calibrated. The probes 2, 3 are mounted on a granite base 4, and the arrangement for moving the probe 3 is housed within a casing 5. A single control 6 is provided on the casing 5 for controlling movement of the probe 3 towards and away from ("IN-OUT") the fixed probe 2.

A single output line 7 from the measuring instrument 1 leads to a data processing system 8 comprising a counting interface 9, a micro-processor 10 with floppy disc store 11, a visual display unit 12, and a printer 13.

The measuring instrument 1 is shown in more detail in Figures 2 to 6.

The granite base 4 has a flat, smooth upper face 14 which is lapped to A+grade to give a very precise finish and flatness. The fixed and moveable probes 2, 3 are also of granite, and have their under faces lapped to the same A+grade as the upper face of the base 4. The low thermal conductivity of granite gives a high inherent dimensional stability under moderate changes of temperature, and granite has the

capability of being lapped to the high standard of finish and flatness that is required.

The movable probe 3 is supported at three points on air bearings. A front air bearing 15 is provided adjacent the front of the proble 3, and two rear air bearings are provided adjacent the rear of the probe 3. It is to be appreciated that the three point bearing systems provides for particularly good stability of the probe 3. The spacing of the front bearing from the rear bearings gives stability against possible pitching, and the spacing of the two rear bearings 16 gives stability against possible rolling of the probe. The air bearings, acting on the flat upper face 14 of the base 4, confer a low lever of resistance to movement, minimum stick-slip characteristics, a low wear rate and adequate stiffness to enable accurate repeatable measurements to be made.

The probe 3 is guided laterally by two pairs of side air bearings 17 and 18. Each pair of side air bearings acts upon opposite sides of the probe 3 (which sides are appropriately finished to be flat and parallel), to afford stability against possible yawing of the probe 3.

The moveable probe 3 is urged towards or away from the fixed probe 2 by means of pneumatic rams 19, each of which comprises a graphite piston in a glass air cylinder, which arrangement gives rise to very low friction forces. Compressed air is supplied selectively to the rams 19 by the circuit 20 illustrated in Figure 5, which comprises a changeover switch 21 and a pressure regulating valve 22. Adjustment of the valve 22 affords adjustment of the constant force applied by the rams 19 to the moveable probe 3, and because of the very low static and dynamic friction of the whole system, low probe forces of, for example, 8 oz.wt., may be utilized. The consistent probe force obtainable in this way may give accuracy of measurement of 0.00001" or better.

As an alternative to the illustrated pneumatic system, hydraulic or electromagnetic devices may be used to apply force to the probe 3. If desired, control means may be provided for moving the probe 3 gently into a measuring position, under a low force, and then increasing force on the probe, once it abuts a gauge to be measured.

Both the fixed and moveable probes 2, 3 carry tungsten carbide faced slips 23, which are detachably secured to the respective probes. Each slip 23 has a flat smooth abutment face 24 for contact with a gauge to be measured, at least one flat smooth side face 25, and a flat smooth under face 26. The faces 24, 25 and 26 are precisely at right angles to one another. The upper faces of the probes 2, 3 are lapped to A+grade. Thus, the slips 23 can be very accurately placed on the probes 2, 3, with their abutment faces 24 precisely parallel. A fixed dial gauge or the like may engage with the side faces 25 to check for alignment of the slips 23.

The slips 23 as shown in Figure 4 are adapted for external measurement of a gauge. As shown in Figure 3, adaptors 27 may be secured each to a respective one of the slips 23, to enable internal measurements to be carried out. Each adaptor 27 comprises a bracket carrying a tungsten carbide or ruby precision ball 28 in a respective aperture, the axis of which is exactly parallel to and at a precise distance from the under face of the bracket. The balls 28 are aligned by means of a simple gauge 29, comprising a steel slip with a small hole 30 drilled accurately therethrough from one side. The balls 28 are aligned to fit opposite ends of the hole 30.

In order to mount various different gauges to be calibrated, there is provided a support table 31 which is generally T-shaped and is supported on the base 4 by means of three spaced air bearings 32, for stability. The table 31 is constrained for limited movement within a frame (not shown), and the table 31 with frame is moveable manually to a desired portion on the base 4, for coarse positioning of a gauge. The table 31 includes a support surface 33, the plane of which 13 adjustable by means of three spaced screws 34. A number of interchangeable support members (e.g. centres, support clamps, etc.) may be detachably secured to the support surface 33, to support various different gauges.

Movement of the probe 3 is detected and measured by means of an opto-electronic reading head 35, which reads a high precision graticule scale 36, on glass, and outputs two sine waves 90° out of phase, on the line 7.

Briefly, calibration of a gauge is carried out as follows.

Firstly, a zeroing operation is carried out. To do this, a known standard is placed between the abutment faces 24 of the slips 23, and the operator moves the control 6 to the "IN" position, whereby the moveable probe 3 is brought to bear against the standard with a substantially constant force, such that the standard is held between the abutment faces 24. A measurement reading of the standard appears on the visual display unit 12, and any calibration areas are deduced therefrom.

Then, the gauge to be calibrated is supported on the table 31, by means of suitable support members which are adapted to take the particular type of gauge. The support table 31 is then moved until the gauge is positioned coarsely between the abutment faces 24 of the slips 23. Then, the operator again moves the control 6 to the "IN" position to bring the moveable probe 3 to bear against the gauge, until the gauge is held between the opposing abutment faces 24. Any fine movement of the gauge is permitted by movement of the support table 31 on its three air bearings 32. Any necessary adjustment of the orientation of the gauge is effected by adjustment of the three spaced screws 34.

A measurement reading for the gauge is then obtained on the visual display unit 12, and any necessary correction may be made, by reference to the previous zeroing operation.

It will be appreciated that the above described operation relates to an external measurement,

using the abutment faces 24. An internal measurement is carried out in an analogous manner, using the adapters 27 as shown in Figure 3.

The data processing system 8 greatly facilitates the calibration of gauges, and may provide a number of functions, or routines, as follows:

1. Setting routine.
2. Listing routine—gauges due for calibration.
3. Measuring routine (with data storage).
4. Measuring routine (no data storage).
5. Data input routine.

In all of the above routines, the micro-computer 10 displays on the visual display unit 12 a set of instructions to the operator, telling him what to do next. The microcomputer 10 may also send certain control instructions to the measuring instrument 1 itself. A brief description of the above routines will now be given.

1. Setting routine

Here, a zeroing operation is carried out, as outlined above. The micro-computer 10 askes the operator which standard is being used to zero the instrument 1, and the operator inputs this data. The operator then carries out a zeroing operation as outlined above, under appropriate instruction from the micro-computer 10, *via* the visual display unit 12. The computer then stores any necessary correction errors; resulting from the zeroing operation.

2. Listing routine

As has been mentioned above, it is important that gauges are checked regularly. In the listing routine, the micro-computer 10 lists all gauges which are due for calibration which a specified time period. Thus, the micro-computer 10 asks the operator to identify the time period for which a listing is required and outputs a data list accordingly. Such a list would normally be printed on the printer 13. If desired, a listing routine may also be restricted to a particular batch or type of gauges.

3. Measuring routine (with data storage)

Firstly, the micro-computer 10 asks the operator to identify the gauge that is to be calibrated. This could be done with a simple code number, and the operator enters the data accordingly. The micro-computer 10 then instructs the operator how to carry out the measuring operation, and displays the measurement result continuously. When the operator is satisfied with the measurement reading, he indicates this to the micro-computer 10, which then stores the measurement reading accordingly. The micro-computer 10 may display continuously not only the actual measurement reading, but also the corrected measurement reading, to take into account any calibration errors. The micro-computer 10 may store any number of calibration details for various parts of the measuring instrument 1, such as a calibration of the glass scale 36, for example.

When the data has been entered into the micro-computer store, the micro-computer 10 may then optionally display the total record for the particular gauge being calibrated. For example, the record may include the date, the type of gauge, the particular gauge identification, the calibration frequency for the gauge, whether the gauge is imperial or metric, whether the gauge has "go" and "no go" ends, and measurement information. The measurement information may include nominal dimensions for the gauge (and for each of its "go" and "no go" ends, if appropriate), such as maximum and minimum permitted dimensions, the last dimension measurement, and the present dimension measurement. Advantageously, the micro-computer 10 is arranged to extrapolate from the existing data the probable next dimension measurement, at the next due calibration date.

Obviously, if it was found during the measurement routine that the gauge was outside its specified tolerance, then this would be indicated in a prominent manner. Also, if the probable next measurement extrapolation was outside the specified tolerences, then this would also be indicated in a prominent manner.

4. Measuring routine (no data storage)

This is a more simple routine, where it is desired to use the measuring instrument 1 simply to calibrate a gauge, without the necessity for entering details of the measurement into the gauge record system. Here, the micro-computer 10 simply requires the operator to identify the type of gauge to be calibrated, and then provides him with a set of simple instructions to carry out the measurement, as outlined above. The printer 13 may give a print out of the actual and corrected measurement values, if desired.

5. Data input routine

This routine is used simply to enter data into the system 8, without involving a measurement operation as such. Here, the micro-computer 10 simply asks the operator to identify the type of gauge and input the relevant data. It may be appreciated that the data input routine may be used to store in the system 8 details not only of dimension gauges, which may be calibrated regularly by the measuring instrument 1, but also details of any other type of gauges (e.g. temperature gauges, pressure gauges, etc.), which may not be capable of calibration by the measuring instrument 1, but details of which may be conveniently stored in the system 8, as opposed to conventional manual record systems.

It is mentioned above that the single output line 7 from the measuring instrument 1 carries two sine waves, 90° out of phase, from the reading head 35. The counting interface 9 converts these sine waves into a BCD count signal, which is fed to the micro-computer 10.

The phase difference between the two sine waves serves to indicate the direction of movement on the probe 3.

It will be appreciated that the counting interface 9 is required to have a very considerable resolution, as the measuring instrument 1 may measure to an accuracy of 10^{-5} inch, over a range of several inches. It is not practical to process the BCD count signal formed in the interface 9 in a parallel manner, because the number would require too large a field to be conveniently handled by the micro-computer 10. Thus, the BCD count number is fed to the micro-computer 10 in a serial manner. To this end, the counting interface 9 continuously samples the BCD count signal, and sends the bits of the number one at a time to the micro-computer 10. Thus, whilst the arm 3 is moving, a displayed measurement signal on the visual display unit 12 changes accordingly, although the displayed value on the unit 12 is not accurate until the probe 3 has ceased movement and the final BCD count number in the interface 9 has been fully scanned and fed into the micro-computer 10. In this manner, a relatively modest micro-computer 10 is able to handle a fairly large range for the measurement values appearing on the visual display unit 12. This is an important and novel aspect of the system.

The illustrated gauge calibration system thus affords means for calibrating a large number of gauges in a simple and reliable manner, and automating the recordal of gauge calibration. The measuring instrument 1 may be used with the majority of dimension gauges, whilst the data processing system 8 may store data records of all gauges in a given environment. The measuring instrument 1 is designed for single handed operation, and preferably is at least partly under the control of the micro-computer 10. This, together with the sets of instructions provided by the micro-computer 10, enables gauge calibration and recordal with a minimum of skill and experience. The whole system simplifies and reduces the tedium of controlling the calibration of a large family of gauges. The speed of the calibration and recording process is increased and the accuracy of record maintenance is improved. Analysis of gauge records and recall as required is facilitated. Security of data is enhanced by copying of the floppy discs, upon which the data is stored, at regular intervals.

Another advantage of the gauge calibration system is that it is "self-programming". By this it is meant that it is possible to introduce the system over a period of time. Thus, in an existing environment, each gauge is calibrated at its next due date by means of the illustrated system, at which time all details of the gauge are entered into the system. From then on, the data is stored in the system.

The illustrated measuring instrument may be adapted to carry out measurements in the range, for example, 0—6 inches or 0—9 inches. If desired, the granite base 4 can be extended, and provided with means for securing the fixed probe 2 at any one of a plurality of desired positions. In this way, the instrument may be extendable as desired to carry out measurements in the ranges 0—12 inches or 0—18 inches, for example.

Claims (Filed on 7·1·83)

1. A measuring instrument comprising a base and a probe which is movable on the base, towards and away from a measuring position, the probe being supported on the base by means of three spaced air bearings.

2. A measuring instrument according to Claim 1, wherein one of the air bearings is mounted at or adjacent a front end of the probe, and the other two air bearings are mounted at or adjacent a rear end of the probe.

3. A measuring instrument according to Claim 1 or 2, further comprising at least one pair of oppositely facing further air bearings, adapted to guide respective side faces of the probe.

4. A measuring instrument according to Claim 3, wherein two pairs of said further air bearings are provided, spaced along the length of the probe.

5. A measuring instrument comprising a probe which is moveable towards and away from a measuring position, and means for applying a constant force to the probe to maintain the probe in a measuring position.

6. A measuring instrument according to Claim 5, wherein said means is adjustable to adjust said constant force.

7. A measuring instrument according to Claim 5 or 6, wherein said means comprises an electromagnetic device.

8. A measuring instrument according to Claim 5 or 6, wherein said means comprises an hydraulic device.

9. A measuring instrument according to Claim 5 or 6, wherein said means comprises a pneumatic device.

10. A measuring instrument according to Claim 9, wherein said pneumatic device comprises a graphite piston in a glass air cylinder.

11. A measuring instrument according to Claim 10, wherein said pneumatic device is adaptable to apply force selectively in one of two opposite directions.

12. A measuring instrument according to Claim 11, wherein a pair of glass air cylinders are provided, each having a respective graphite piston therein, and each being adapted to operate in a respective one of said two opposite directions.

13. A measuring instrument according to any one of Claims 9 to 12, wherein the pneumatic device includes at least one pressure regulator valve for the adjustment of said constant force.

14. A measuring instrument according to any one of Claims 1 to 4, and any one of Claims 5 to 13.

15. A measuring instrument comprising a probe which is moveable towards and away from a measuring position, and a slip mounted on the probe, for contact with an object to be measured.

16. A measuring instrument according to

Claim 15, wherein the slip is removeably mounted on the probe.

17. A measuring instrument according to Claim 15 or 16, wherein there are provided a plurality of interchangeable slips for mounting on the probe.

18. A measuring instrument according to Claim 15, 16 or 17, wherein the or each slip comprises a flat smooth under face adapted to be mounted on a similarly flat smooth upper face of the probe, and a flat smooth abutment face precisely at right angles to said under face, for contact with an object to be measured.

19. A measuring instrument according to Claim 18, wherein the or each slip further comprises a flat smooth side face precisely at right angles to its respective said abutment face.

20. A measuring instrument according to any one of Claims 15 to 19, wherein there is provided at least one slip having a flat smooth under face adapted to be mounted on a similarly flat smooth upper face of the probe, and an upstanding arm carrying a ball for contact with an object to be measured.

21. A measuring instrument according to any one of Claims 1 to 14 and any one of Claims 15 to 20.

22. A measuring instrument comprising support means for supporting an object at a measuring position and sensor means for sensing an object at said position, the support means comprising a table supported on air bearings, and constrained for limited movement within a frame around the table.

23. A measuring instrument according to Claim 22, wherein said frame is movable over a surface of the measuring instrument.

24. A measuring instrument according to Claim 22 or 23, wherein the support table is supported on three said air bearings.

25. A measuring instrument according to Claim 22, 23 or 24, wherein the support table is generally T-shaped.

26. A measuring instrument according to any one of Claims 22 to 25, wherein the support table is provided with a support surface, the plane of which is adjustable.

27. A measuring instrument according to Claim 26, wherein the support surface is secured in position by means of three screw-threaded adjustable members.

28. A measuring instrument according to any one of Claims 22 to 27, wherein there are provided a plurality of interchangeable support members which are adapted to be detachably secured to the support table.

29. A measuring instrument according to any one of Claims 1 to 21 and any one of Claims 22 to 28.

30. A measuring instrument according to any preceding claim, wherein the base of the measuring instrument is of granite, having a flat, smooth upper face on which the probe or sensor means is mounted.

31. A measuring instrument according to any preceding claim, wherein the probe or sensor means is of granite.

32. A measuring instrument according to any preceding claim, including an opto-electrical reading head for detecting movement of the probe or sensor means and providing an electrical signal proportional thereto.

33. A measuring instrument according to any preceding claim, comprising a moveable probe which co-operates with a fixed probe to measure objects therebetween.

34. A measuring instrument according to Claim 33, wherein the fixed probe may be located selectively at any one of a plurality of predetermined positions.

35. A measuring instrument according to any preceding claim, including probe members for measuring internal dimensions, each probe member comprising an upright portion in which a precision ball is mounted.

36. A measuring instrument according to Claim 35, including an alignment device for aligning said probe members, the device being formed therethrough with a single hole, of a diameter to accept part of one of said balls at each mouth of the hole.

37. A measuring instrument according to any one of Claims 1 to 29, and any one of Claims 30 to 36.

38. A measuring system substantially as hereinbefore described with reference to the accompanying drawings.

39. A data processing system adapted to receive and store data from a measuring instrument, output such stored data, and output a set of instructions to a user of the instrument.

40. A data processing system according to Claim 39, including an interface adapted to receive electrical signals directly from a measuring instrument, and output data signals for storage in the data processing system.

41. A data processing system according to Claim 40, wherein, the interface is adapted to sample an electrical signal from a measuring instrument, and pass the sampled values successively to a store of the system.

42. A data processing system according to Claim 41, wherein the interface is adapted to sample continuously successive bits of a binary coded number.

43. A data processing system according to Claim 42, wherein the binary coded number is generated in the interface.

44. A data processing system according to Claim 43, wherein the interface is adapted to sample said bits only one at a time.

45. A data processing system according to any one of Claims 39 to 44, including display means for displaying an output of the system.

46. A data processing system according to any one of Claims 39 to 45, including printer means for printing an output of the system.

47. A data processing system according to any one of Claims 39 to 46, adapted to output any

selected one of a plurality of sets of instructions to a user of a measuring instrument.

48. A data processing system according to Claim 47, wherein said sets of instructions comprise a set of zeroing instructions, for zeroing the respective instrument, and a set of measuring instructions, for carrying out a measurement.

49. A data processing system according to Claim 47 or 48, wherein said sets of instructions comprise a set of measuring/storing instructions, for carrying out a measurement and storing the data, and/or a set of data input instructions, for storing data without a measurement operation, and/or a set of object listing instructions, for listing objects due to be measured.

50. A data processing system according to any one of Claims 39 to 49, adapted to extrapolate probable future measurement data from existing actual measurement data.

51. A data processing system according to any one of Claims 39 to 50, adapted to receive measurement data from a dimension measuring instrument.

52. A data processing system according to Claim 51, adapted to receive measurement data from a dimension gauge calibration instrument.

53. A data processing system according to any one of Claims 39 to 52, adapted to output control instructions to a respective measuring instrument.

54. A data processing system substantially as hereinbefore described with reference to the accompanying drawings.

55. A data processing system according to any one of Claims 39 to 54, in combination with a measuring instrument.

56. A data processing system according to Claim 55, wherein the measuring instrument is in accordance with any one of Claims 1 to 38.

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